The Embodiment of Approach Motivation

Eddie Harmon-Jones, Tom F. Price, & Cindy Harmon-Jones

The University of New South Wales

Abstract

One of the most fundamental and important aspects of motivation is the urge to approach, which is manifest in its most basic form by moving toward (Harmon-Jones, Harmon-Jones, & Price, in press). Although much research has examined cognitive influences on approach motivation, less research has examined bodily influences. In this chapter (talk), we will present the results of a program of research that has examined how body posture influences approach motivation. The research has manipulated approach motivation from low to high intensity by placing participants in a supine vs. leaning forward posture, respectively. In the presence of approach-related stimuli, leaning forward enhances approach responses, whereas lying down reduces these responses. These bodily manipulations influence a number of responses associated with approach motivation, including simple reflexes, early visual cortical activations, asymmetric frontal cortical activations, and cognitive responses. These results illuminate the role of the body in motivational processes, as they show that approach motivation is partially dependent on the action-readiness of the body.

Emotion and motivation are fundamental to movement. This idea is not only captured in scientific research on emotion and motivation but also reflected in the English language. The word "emotion" is derived from the French word "émouvoir," which is based on the Latin word "emovere," where e- (variant of ex-) means 'out' and movere means 'move'. The word "motivation" is also derived from "movere." Thus, the meaning of the English words, emotion and motivation, are derived from words that mean to move and movement requires the body for its enactment or expression.

Often, laypersons and scientists alike conceive of our perceptions or cognitions of psychobiologically significant stimuli as the sole cause of our motivational states. But is this accurate? Is motivation fundamentally traced back to only our perceptions or cognitions of stimuli? Or might our actions or behaviours influence our motivational states? Although evidence exists supporting the idea that facial expressions influence emotional experience, far less evidence has tested whether bodily movement influences motivation, even non-conscious aspects of motivation. In this chapter, we review a program of research that provides support for the notion that that body posture influences motivation even at non-conscious levels.

Brief Review of Influence of Facial and Bodily Expressions on Emotive States

The majority of research on the role of bodily expressions influencing processes related to motivation comes from work on facial expressions and emotions. The idea that facial expressions are closely connected with emotions was recognized over 100 years ago by Darwin (1872) and James (1890). Building upon these ideas, Laird (1974) proposed the facial feedback hypothesis that posited that manipulated facial expressions of emotion cause changes in emotional feelings (for a review, see Adelmann & Zajonc, 1989).

This hypothesis is typically tested by manipulating participants' facial expressions with specific muscle configuration instructions or through non-obtrusive methods. For example, participants have been induced to hold a pen between their teeth to facilitate smiling or to hold a pen with their lips to inhibit smiling (Strack, Martin, & Stepper, 1988). Once the facial expression manipulation is in place, participants will be presented with a stimulus and instructed to give their emotional reactions to the stimulus. Experiments such as these have revealed that when smiling is facilitated as compared to inhibited, participants respond more positively to cartoons (Strack et al., 1988). Other methods have revealed conceptually consistent results. For instance, when the responsiveness of individuals' facial muscles has been reduced by administration of botulinum toxin-A (BTX), individuals are slower at reading of emotional passages (Havas, Glenberg, Gutowski, Lucarelli, & Davidson, 2010) and have decreased amygdala activation during intentional facial mimicry (Hennenlotter et al., 2009).

Zajonc and colleagues proposed that one mechanism by which facial expressions may influence emotional feelings is that the movement of facial muscles influences other physiological processes (Zajonc, Murphy, & Inglehart, 1989). Zajonc et al. (1989) posited that the furrowing of the brow (i.e., the downward movement of the corrugator supercilii muscle) that often occurs during expressions of negative emotions such as anger might reduce air-intake into the nasal cavity, cause more mouth- as compared to nose-breathing, and raise the temperature of blood entering the brain. This rise in facial temperature would cause the experience of negative affect. In contrast, activation of the muscles involved in smiling (i.e., contraction of the zygomatic major muscle) should open the nasal cavity, improve nose breathing, and reduce the temperature of blood entering the brain. This reduction in facial temperature due to smiling would cause the experience of positive affect. These predictions were based on the idea that thermoregulation of brain areas such as the hypothalamus could influence hedonic states and associated neurotransmitter (e.g., norepinephrine) activity.

Zajonc and colleagues (1989) tested these ideas by having participants recite sounds that caused greater or lesser brow furrowing, and found that greater brow furrowing caused higher facial temperatures and more negative evaluations of information. In addition, they found that when cool air was infused into participants' nasal cavities, they had reduced overall facial temperature. Subsequent research directly manipulated hypothalamic cooling vs. heating in rats, and found that cooling caused more eating but not more hedonic reactions to taste. Zajonc and colleagues suggested that hypothalamic cooling may increase the attractiveness of the food without modulating taste pleasure (Berridge & Zajonc, 2001). These results suggest that facial expressions influence thermoregulation of the hypothalamus which, subsequently, influences an organism's emotional state.

Other mechanisms for the facial feedback responses have been suggested. One is that facial expressions of emotion cause innate, parallel physiological changes in heart rate, skin conductance, and other measures of autonomic nervous system activity (Ekman, Levenson, & Friesen, 1983). Levenson, Ekman, and Friesen (1990) instructed participants to move individual facial muscles to form facial expressions of discrete emotions such as anger and fear. Once the facial expressions were fully created, participants' heart rate, skin conductance, finger temperature, and forearm muscle tension were recorded. Over several experiments, Levenson et al. (1990) found that facial expressions of discrete emotions caused discrete patterns of autonomic nervous system activity. For example, facial expressions of anger, sadness, or fear caused greater heart rate acceleration than that found with the expression of disgust. Facial expressions of anger caused higher finger temperature than expressions of fear. Subsequent studies replicated these original results, which were obtained with American samples, with men of the Minangkabau from West Sumatra (Levenson, Ekman, Heider, & Friesen, 1992).

Taken together, these results suggest that facial expressions have direct effects on thermoregulation of certain brain structures and autonomic nervous system activity. But how does the brain/body transform these signals into subjective emotional states? Some researchers have proposed that projections from the brainstem, which carries sympathetic and parasympathetic bodily signals, to nuclei within the anterior insular cortex and the anterior cingulate cortex are involved in this process (for a review, see Craig, 2002, 2009). Another critical region in these processes is the somatosensory cortex (Damasio, 1993).

Although the majority of research has focused on manipulations of facial expressions of emotions, other bodily manipulations have been used in a few studies. For instance, some studies have found that when individuals nod their heads up and down, as compared to shake their heads from side to side, they have more positive attitudes toward neutral stimuli (Tom, Pettersen, Lay, Burton, & Cook, 1991) and are more likely to agree with persuasive messages (Wells & Petty, 1981).

Other research has found that flexing the arm, a movement associated with acquiring desired stimuli, causes individuals to form more positive attitudes toward neutral stimuli. In contrast, extending the arm, a movement associated with avoiding undesirable stimuli, causes individuals to form more negative attitudes toward neutral stimuli (Cacioppo, Priester, & Berntson, 1993). Subsequent research has found that the positivity/negativity of the stimuli can influence these arm-flexion and arm-extension effects (Centerbar & Clore, 2006). Moreover, the meaning attributed to these types of motor actions is also an important factor (Eder & Rothermund, 2008).

Brief Review of Asymmetric Frontal Cortical Activity and Emotive States

One neural variable that has received considerable attention is asymmetric frontal cortical activity. Observational studies dating back to the 1930s suggested that damage to the left versus right frontal cortex yielded very different emotive consequences. That is, damage to the right frontal region is associated with the onset of mania symptoms (Starkstein, Boston, & Robinson, 1988). In contrast, damage to the left frontal region (Robinson, Boston, Starkstein, & Price, 1988) is associated with depression symptoms. One interpretation of this research is that lesions to the left frontal region reduce or eliminate the organism's capability to experience and express positive affect and/or approach motivation. The converse would be the case for the right frontal region. Another interpretation is that with the left frontal region's functioning reduced or eliminated, the right frontal region's functioning is over-expressed and thus more negative affect (e.g., depression) is presented, and vice versa. This latter interpretation assumes there is a reciprocal connection between activities in the left versus right frontal cortical regions, such that when one hemisphere is taken off-line, the other becomes over-active.

The emotive functions of asymmetric frontal cortical activity have been tested with a host of neuroscience techniques, including functional magnetic resonance imagining (Berkman & Lieberman, 2010), event-related brain potentials (Cunningham et al., 2004), repetitive transcranial magnetic stimulation (van Honk & Schutter, 2007), transcranial direct current stimulation (Hortensius, Schutter, & Harmon-Jones, 2012; Kelley, Hortensius, & Harmon-Jones, in press), and electroencephalographic (EEG) recordings (Harmon-Jones, 2003; Harmon-Jones, Gable, & Peterson, 2010). In this body of research, relative right frontal activity has been associated with withdrawal-oriented emotions, such as fear and disgust (Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Jones & Fox, 1992), and relative left frontal activity has been associated with approach-oriented emotions, such as joy (Davidson & Fox, 1982) and anger (Harmon-Jones, 2004; Harmon-Jones & Allen 1998; Harmon-Jones & Sigelman, 2001; Harmon-Jones, Vaughn-Scott, Mohr, Sigelman, & Harmon-Jones, 2004;

Verona, Sadeh, & Curtin, 2009). Research has also been conducted with bodily manipulations to further test the emotive functions of asymmetric frontal cortical activity.

The Influence of Facial Expressions and Unilateral Body Movements on Asymmetric Frontal Cortical Activity and Approach Motivation

Facial Expressions

In one of the first experiments to test whether manipulated facial expressions of emotion would influence asymmetric frontal cortical activity, Ekman and Davidson (1993) instructed participants to form one of two smiles while EEG was recorded. Some participants were instructed to contract their zygomatic major (cheek) and orbicularis oculi (underneath the eye) muscles. This was done to create genuine smiles that involve Duchenne's marker, activation of the orbicularis oculi muscles. Other participants were instructed to contract their zygomatic muscles only to form less genuine smiles. Ekman and Davidson (1993) found that participants who formed Duchenne's smiles had greater relative left frontal cortical activity than participant who formed smiles without this marker.

Another experiment tested the effect of manipulated facial expressions of the discrete emotions of anger, joy, fear, sadness, and disgust on asymmetric frontal cortical activity. Consistent with the idea that asymmetric frontal cortical activity is associated with the motivational direction (approach vs. avoidance) of emotion, the researchers found that facial expressions of joy and anger, approach-oriented emotions, increased relative left frontal cortical activity, whereas facial expressions indicative of fear and disgust, withdrawal-oriented emotions, reduced relative left frontal activity (Coan, Allen, & Harmon-Jones, 2001).

Price, Hortensius, and Harmon-Jones (2013) recently extended the work on facial expressions and asymmetric frontal cortical activity by testing how facial expressions of positive emotions that differ in approach motivational intensity influence relative left frontal cortical activity. Positive emotions vary in approach motivational intensity (Gable & Harmon-Jones, 2008). If relative left frontal cortical activity is indeed associated with approach motivational intensity, then positive emotions higher in approach motivational intensity should evoke greater relative left frontal activity than positive emotions lower in approach motivational intensity. Based on research demonstrating that determination is an emotion that is positive in valence and high in approach motivation (C. Harmon-Jones et al., 2011) and other evidence that satisfaction is an emotion that is positive in valence and lower in approach motivation, participants were instructed to make facial expressions of determination, satisfaction, or neutrality. That is, they were simply requested to make their face appear as though they were feeling determined, satisfied, or neutral. This was done because the specific muscles involved in these expressions have yet to be quantified. In addition, this was done because determination facial expressions and angry facial expressions are perceptually confused (C. Harmon-Jones et al., 2011), and thus provided muscle-by-muscle instructions for facially expressing determination may instead cause one to feel angry. Results from the experiment revealed that when individuals expressed determination, their relative left frontal activity increased as compared to baseline. In contrast, when individuals expression satisfaction or neutral affect, their relative left frontal activity did not increase as compared to baseline. In addition, within the determination facial expression condition, relative left frontal cortical activity was correlated with more task persistence on an impossible line-tracing task, suggesting that determination-related left frontal cortical activity was related to behavioral persistence.

In sum, the above studies suggest that approach-related facial expressions cause greater relative left frontal activity. It is important to note that these effects occurred in relatively neutral situations, in the absence of external cues impelling approach motivation. As such, they suggest that bodily expressions per se can serve as stimuli that cause neural activations associated with approach motivation. But do other body movements also influence indices of approach motivation?

Unilateral Body Movements

Based on research suggesting close connections between the motor cortex and frontal cortex (Harmon-Jones, 2006; Schiff & Lamon, 1989, 1994), research has tested whether moving one side of the body – a unilateral body movement – would activate the contralateral motor cortex and frontal cortex. That is, because during many motor actions – brain hemisphere pathways are crossed (Rinn, 1984), unilaterally moving the right side of the body should be associated with an increase in left hemispheric motor cortex activation, whereas moving the left side of the body should be associated with an increase in right hemispheric motor cortex activation. These increases in contralateral motor cortex activation may, through spreading of activation, increase activity in frontal areas. Indeed, EEG research has supported these ideas (Peterson, Shackman, & Harmon-Jones, 2008).

Beyond these neural effects, we have tested whether unilateral body movements influence emotive states. That is, we would expect that right-sided body movements would increase activity in the left motor cortex and left frontal cortex, which would then prime one to respond in a more approach-motivated manner. One experiment tested these ideas (Harmon-Jones, 2006) by having right-handed participants squeeze a ball with either their right or left hand for two 45 second periods while they listened to a mildly positive, approach-oriented pilot radio broadcast that concerned apartment living options. As expected, right-hand contractions compared to left-hand contractions caused greater relative left frontal activation (and activation over the left motor cortex). Moreover, right-hand contractions caused greater self-reported approach affect as measured by scores on the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988).

Peterson, Shackman, and Harmon-Jones (2008) extended this work to test whether unilateral hand contractions would influence behavioral responses associated with approach motivation. In this experiment, right-handed participants first wrote an essay on a controversial topic. Then, they received insulting feedback on their essays from another ostensible participant. Immediately prior to receiving the feedback, participants squeezed a ball with either their right or left hand in order to increase relative left or right frontal cortical activity, respectively. Participants were then told they would play a reaction time game against the other participant who had given them insulting feedback. In this modified version of Taylor's (1966) aggression game, participants could aggress against the other player with blasts of noise. Results revealed that, compared to participants who made left-hand contractions, participants who made right-hand contractions gave longer and louder noise blasts during the reaction time game. Moreover, within the right-hand contraction condition, greater relative left frontal cortical activity correlated with more aggressive behavioral responses.

The results from these experiments reveal that unilateral movements of the body influence asymmetric frontal brain activity as well as approach-related affective experiences and behavior. These findings suggest one neural mechanism by which unilateral body movements might influence motivational processes.

The Influence of Whole Body Posture Manipulations on Physiological Indices of Approach Motivation

One area that has received only a little research attention is the role of whole body postures on psychological processes. This is surprising, given that whole body displays often seem to communicate psychological states to others. We believe that others are interested in hearing our stories when they lean toward us. We suspect that someone is depressed when she is slumped down, and we surmise that she is particularly at ease with life when she is reclined backward. However, to our knowledge, relatively little research has tested whether whole body postures such as these influence psychological processes such as approach motivational states. One set of experiments reported over three decades ago did provide some support for the idea that whole body postures can influence motivation. In this set of two experiments, Riskind and Gotay (1982) assigned participants, under the guise of a biofeedback study, to adopt a slumped/helpless posture or an upright/expansive posture. Then, participants completed insolvable puzzle tasks as a measure of task persistence. Participants who were assigned to adopt the slumped posture persisted less on the insolvable tasks as compared to participants who were assigned to adopt the upright posture.

Based on these results by Riskind and Gotay (1982) and our intuitions about body postures and approach motivation, we have conducted a few experiments to test whether another whole body posture would influence approach motivation. In particular, we reasoned that a supine or reclining posture, compared to an upright posture, would reduce approach motivation, as supine, reclining postures are often associated in our everyday lives with relaxation and goal accomplishment. That is, reclining backward often occurs following the acquisition of a desired goal, such as after eating a delicious meal.

Influence of Whole Body Posture on Asymmetric Frontal Activity to Emotive Stimuli

In our first test of this idea, we predicted that a reclining posture would reduce relative left frontal cortical activation associated with approach-motivated anger (Harmon-Jones &

Peterson, 2009). In the experiment, participants wrote an essay on a controversial topic and were led to believe that another ostensible participant would evaluate it. Immediately prior to receiving feedback on their essay, participants were instructed to remain upright in their chair or to place it in the reclined position. All participants in the reclining condition and half the participants in the upright condition received insulting feedback; the other half of the participants in the upright condition received neutral feedback. Results revealed participants in the insult-upright condition had greater relative left frontal cortical activity compared to participants in the neutral-upright condition, replicating the results of several past experiments (e.g., Harmon-Jones & Sigelman, 2001). More importantly, participants in the insult-reclined condition had less relative left frontal cortical activity than participants in the insult-upright condition. Moreover, participants in the insult-reclined condition did not differ in terms of relative left frontal activity from participants in the neutral-upright condition. These results suggest that being in a supine body position reduces brain activity associated with approach-motivated anger. Interestingly, these results were predicted in a statement made over 1400 years ago by the Prophet Mohammad: “When one of you becomes angry while standing, he should sit down. If the anger leaves him, well and good; otherwise he should lie down.” [Abu Daud; Book 41, No. 4764].

Price and Harmon-Jones (2010) extended this experiment with multiple postures hypothesized to be associated with different levels of approach motivation. As in the previous experiment, reclining backward was hypothesized to be associated with lower approach motivation. A new condition, leaning forward, was added to evoke higher approach motivation. Leaning was used because it often occurs during goal acquisition, such as leaning towards a delicious meal. A third body posture was included -- sitting upright, and it was hypothesized to be associated with a level of approach motivation between reclining backward and leaning forward. In this experiment, participants were in one of these three postures while EEG was recorded for one minute. Results revealed that reclining backward caused participants to have less relative left frontal cortical activity as compared to leaning forward. Moreover, sitting upright caused a level of relative left frontal activity that was between these two conditions, as predicted.

To test whether this whole body posture manipulation would influence responses to desirable, appetitive stimuli, we next conducted an experiment in which participants leaned forward or reclined backward while viewing appetitive dessert and neutral rock pictures (Harmon-Jones, Gable, & Price, 2011). As expected, when participants were leaning forward, they had greater relative left frontal activity to dessert as compared to neutral rock pictures. In contrast, when they were reclining, they had similar levels of relative left frontal activity to dessert and rock pictures. These results reveal that the whole body posture of reclining versus leaning forward posture influenced relative left frontal cortical activity to appetitive pictures, but not neutral pictures.

This latter result – that the posture manipulation did not influence responses to neutral pictures – could be viewed as inconsistent with the earlier finding that this posture manipulation influences relative left frontal cortical activity during a resting, baseline state or "neutral" state (Price & Harmon-Jones, 2010). We suspect that when one is in a resting, baseline state with no other explicit stimuli to process, such as neutral pictures, the whole body posture itself might have a stronger influence on asymmetric frontal cortical activity. However, when a stimulus is presented, even a neutral one, the stimulus might overwhelm the effect of the body posture. In other words, the effects of body posture observed in a resting, baseline state might be somewhat subtle.

The results from the experiments reviewed in this section have revealed that the embodiment of approach motivation through a whole body manipulation influences relative left frontal cortical activity. In addition to examining this neural correlate of approach motivation, we have examined how this body posture influences other indices related to approach motivation.

Influence of Whole Body Posture on Late Positive Potentials to Emotional Stimuli

One neural variable that has been extensively examined and related to motivational intensity is the late positive potential (LPP). It is an event-related brain potential (ERP) that starts approximately 300 ms after stimulus onset and lasts for several 100 ms (for a review, see Hajcak et al., 2011). LPPs are larger to erotic images than to positive pictures that are less associated with basic motivational impulses, such as exciting sports scenes (Briggs & Martin, 2009). LPPs are also larger when mothers view pictures of their own children's faces compared to pictures of familiar children, unfamiliar children, familiar adults, and unfamiliar adults (Grasso, Moser, Dozier, & Simons, 2009). Individuals who are currently in love with another person have larger amplitude LPPs to pictures of their lover compared to pictures of a friend or a beautiful but unknown opposite-sex person (Langeslag, Jansma, Franken, & Van Strien, 2007). All of these results support the idea that LPP amplitude is associated with approach motivational intensity.

LPP amplitude, however, is not specific to approach motivational intensity, as LPPs are also larger in amplitude to negative affective pictures, such as pictures of mutilation and threat. Moreover, LPPs are larger to these pictures than to pictures of contamination and loss, consistent with the idea that the motivational intensity of the stimulus, regardless of the motivational direction it evokes, determines the amplitude of the LPP (Schupp et al., 2004). The amplitude of the LPP is likely driven by several neural generators, such as the occipitotemporal and parietal cortex, as has been revealed in functional magnetic resonance imagining (fMRI) and EEG studies (Keil et al., 2002; Sabatinelli, Lang, Keil, & Bradley, 2007).

Recently, we tested whether our whole body approach motivation posture would influence this very reliable neural measure of motivated attention to emotional stimuli (Price, Dieckman, & Harmon-Jones, 2012). In the experiment, participants viewed appetitive positive (erotic images) and neutral pictures (images of persons) while leaning and reclining in a counterbalanced within-subjects design. Results revealed that compared to reclining backward, leaning forward caused participants to have larger amplitude LPPs to the appetitive pictures. In contrast, posture did not influence LPP amplitudes to neutral stimuli.

Influence of Whole Body Posture on Startle Responses to Emotional Stimuli

Another variable that has been found to relate to approach motivation is the startle eyeblink reflex. It is reliably modulated by the emotive significance of stimuli (Bradley, Codispoti, Cuthbert, & Lang, 2002; Lang, Bradley, Cuthbert, 1990; Vrana, Spence, & Lang, 1988). The startle eyeblink reflex is part of the full startle response that occurs in response to unexpected, aversive events that are presented suddenly to an individual. It is easily evoked in the lab by presenting individuals with loud (100 db) bursts of white noise with instantaneous rise time (Blumenthal et al., 2005). The startle eyeblink reflex causes the orbicularis oculi muscle around the eye to contract, and it serves the vital function of protecting the eye from harm.

When startle probes are presented during the midst of the viewing of affective pictures, the magnitude of the startle eyeblink is determined by whether the picture evokes an appetitive or avoidance motivational state. Startle eyeblink responses are potentiated during the midst of viewing pictures that evoke avoidance motivation and they are attenuated during the midst of viewing pictures that evoke appetitive motivation. These effects are explained by the response-matching hypothesis, which posits that the magnitude of the defensive startle eyeblink is determined by whether the other stimulus (e.g., affective picture) evokes a motivational state that matches or mismatches the aversive motivational state evoked by the startling stimulus. If the motivational state evoked by the other stimulus (e.g., aversive picture) matches the motivational state of the startle, then the startle response is increased. If the motivational state evoked by the other stimulus (e.g., appetitive stimulus) mismatches the motivational states of the startle, then the startle response is decreased. Thus, smaller startle responses indicate more appetitive responses to the stimuli. This motivational modulation of the startle response is driven by nuclei within the amygdala, as revealed in basic animal neuroscience research (Davis, 2006).

Consistent with the idea that decreased startle responses during the midst of viewing appetitive stimuli reflects approach motivation, individuals high in trait behavioral approach system (BAS) sensitivity, measured with Carver and White’s (1994) scale, show smaller startle responses during arousing positive pictures (Hawk & Kowmas, 2003). Other research has revealed that individuals who score high in trait approach emotions (e.g., anger, enjoyment, surprise) show smaller startle responses during arousing positive pictures (Amodio & Harmon-Jones, 2011). Also, startle responses during positive approach-motivated pictures (e.g., erotic images) are smaller than startle responses during positive pictures lower in basic motivational impulses (e.g., sports scenes; Gard, Gard, Mehta, Kring, & Patrick, 2007).

Returning to our discussion of the effect of body posture on approach motivation, Price et al. (2012) tested whether postures that vary in approach motivation would causally influence startle responses during the midst of viewing arousing positive (appetitive) stimuli. In this experiment, participants were assigned to lean forward or recline while they viewed erotic and neutral pictures (both sets consisted of pictures of people). As is typically done in startle eyeblink research, startle probes (short duration, loud bursts of white noise) were presented 3.5 or 4 seconds after picture onset on during approximately two-thirds of the pictures within a condition. Replicating past research, startle eyeblink responses were smaller during the viewing of arousing positive pictures than during the viewing of neutral pictures. In a novel and embodied extension of past research, the results revealed that leaning forward caused even smaller startle responses during arousing positive pictures (compared to reclining). The body posture manipulation did not influence startle responses during neutral pictures. This experiment suggests that leaning forward promotes heightened approach motivational responses at the reflexive level, which are mediated by activations within cells within the sub-cortical amygdala.

The Influence of Whole Body Posture Manipulations on Approach Emotive-Cognitive Processes

Breadth of Cognitive Scope

Research conducted in the 1980s and 1990s suggested that positive affect impacts cognitive processes related to broadening or cognitive scope differently than negative affect does. One particular cognitive process that had been examined within this line of research was how positive vs. negative affect influenced how individuals categorize related information. That is, positive compared to negative affect broadened basic cognitive categorization, such that individuals in whom positive affect had been induced were more likely to conceptualize categories more widely, so that they were more likely to say, for example, that “camel” fit the category “vehicle” reasonably well (Isen & Daubman, 1984). This research manipulated positive affect by giving participants a free gift or having them watch an amusing film (Isen & Daubman, 1984). This manipulation, however, probably induced low-approach positive affect. That is, when one receives a gift or watches an amusing film, one is not motivated to go toward anything; instead, one passively enjoys the gift or the viewing.

Another line of research has revealed that this distinction of low to high approach motivation within positive affect is critical to understanding whether positive affect broadens or narrows cognitive scope. High-approach, pre-goal positive emotions would be expected to narrow attention, as the organism focuses in on the stimulus in order to acquire it. Over 15 published experiments have revealed that whereas positive affect low in approach motivational intensity broadens cognitive scope, positive affect high in approach motivational intensity narrows cognitive scope (for review, see Harmon-Jones, .Gable, & Price, 2011).

We extended this line of research to test whether a body posture associated with low to high approach-motivated positive affect would influence cognitive scope. In this experiment, high approach positive affect was induced by having participants lean forward in a chair and smile. Low approach positive affect was induced by having participants recline backwards in the chair while smiling. Moderate approach positive affect was induced by having participants sit upright and smile. The smile was induced unobtrusively by having participants raise sensors placed on their checks up toward their ears, so that the "research could investigate how facial muscle movements influenced EEG activity." While in each posture, participants completed the cognitive categorization used by Isen and Daubman (1984). In this task, participants were presented with common (e.g., car) and uncommon (e.g., camel) examples of a category (e.g., vehicle). Participants rated how much they believed each example belonged to the category. As predicted, breadth of categorization showed a linear trend, with participants in the high approach positive affect condition rating uncommon examples as least fitting of the category (narrowed categorization), followed by the moderate approach positive affect condition and then the low approach positive affect condition.

Cognitive Dissonance Reduction

Accumulating evidence demonstrates that cognitive dissonance reduction is associated with approach motivation, particularly when a commitment to action is involved. In support, experiments have revealed that following difficult decisions, individuals who are primed to be high in approach motivation are more likely to spread the alternatives (i.e., evaluate the chosen alternative more favourably and the rejected alternative less favourably; Harmon-Jones & Harmon-Jones, 2002; Harmon-Jones et al., 2008). Correlational studies with conceptually consistent results have revealed that individuals high in trait approach motivation show more dissonance reduction following commitments to difficult decisions and counterattitudinal behaviors (C. Harmon-Jones et al., 2011). In addition, other experiments have revealed that immediately after individuals commit to a chosen course of behaviour, they show increased relative left frontal cortical activity, a neural variable associated with approach motivation (Harmon-Jones, Harmon-Jones et al, 2008; Harmon-Jones, Gerdjikov, & Harmon-Jones, 2008; Harmon-Jones, Harmon-Jones, Serra, & Gable, 2011).

These results were predicted by the action-based model of cognitive dissonance (Harmon-Jones, 1999; Harmon-Jones, Amodio, & Harmon-Jones, 2009). According to this conceptual model, once individuals are committed to a course of action, they should be more approach motivated to follow through with their chosen course of action. That is, they should be more motivated to translate their intended behaviour into effective action, and this approach motivation should be revealed in changes in attitudes that are supportive of the commitment. For example, individuals who have agreed to eat meat (compared to those who agree to eat fruit), reduce dissonance by denying that animals have minds, after being reminded that animals suffer during butchering (Bastian, Loughnan, Haslam, & Radke, 2012). This denial reduces negative affect, and presumably would aid in enjoyment of consuming the meat.

We recently extended this line of research by examining whether our body posture manipulation of approach motivation would influence dissonance reduction. According to the predictions derived from the action-based model, body postures associated with lesser approach motivation should undermine the approach motivation that typically occurs to reduce dissonance. So a supine body posture should decrease dissonance reduction. This prediction was tested in two experiments, one using the difficult-decision paradigm and one using the effort justification paradigm. In the difficult-decision experiment, participants who sat upright showed the typical spreading of alternatives effect, but this effect was eliminated when participants were in a supine body posture. In the effort justification experiment, participants who sat upright and performed a difficult cognitive task evaluated the task incentive more positively than participants who sat upright and performed an easy cognitive task. This replicates the typical effort justification effect. In contrast, participants in a supine body posture did not show this effort justification effect. (Harmon-Jones, Price, & Harmon-Jones, 2013).

Questions, Implications, and Conclusions

Over 20 years ago, Adelmann and Zajonc (1989) asked "What is bodily feedback?" They found that facial expressions influence facial temperature and theorized that this change in facial temperature influenced hypothalamic activity involved in emotional experience. Adelman and Zajonc (1989) recognized that this change was unlikely to be the sole physiological mechanism responsible for facial-feedback effects. The evidence reviewed within this chapter suggests that bodily movements such as facial expressions (Coan et al., 2001; Ekman & Davidson, 1993), hand movements (Harmon-Jones, 2006; Peterson et al., 2008), and changes in physical posture (Harmon-Jones & Peterson, 2009; Harmon-Jones et al., 2011; Price & Harmon-Jones, 2010) associated with approach motivation influence relative left frontal cortical activity. Moreover, manipulated body posture also influences sub-cortically driven emotive processes and event-related brain potentials related to motivated attention (Price et al., 2012). Thus, whole body manipulations along a continuum of approach motivation influence multiple emotion-related physiological processes.

One may question whether this body manipulation continuum that goes from being supine to upright to leaning forward influences avoidance motivation. We have conducted one preliminary test of this idea and found that this body posture manipulation did not influence startle eyeblink and event-related potential reactions to arousing negative pictures.

Another question that has arisen is whether this “approach” motivation body posture is manipulating arousal rather than approach motivation. That is, perhaps the reclining posture is simply reducing general arousal. Arousal is a complex concept, but the available evidence suggests that approach motivation provides a better explanation than “general arousal” for the observed effects. First, the preliminary experiment mentioned above found no evidence that this body posture influences reactions to avoidance-related stimuli. If arousal was the best explanation, then this body posture should have influenced reactions to these stimuli. Second, reclining has not been found to reduce startle responses during neutral stimuli. If reclining were simply reducing general arousal, then it should reduce startle responses during even neutral stimuli, because the startle is an aversive response.

One methodological implication results from this body of work. Functional magnetic resonance imaging (fMRI) studies, at present, require individuals to be in a supine body posture. This may have the unintended consequence of reducing appetitive motivational responses, and may explain why some fMRI studies have failed to find a connection between approach motivation and relative left frontal activity (Tomarken & Zald, 2009) even though several studies using other methodologies, which used an upright body posture, have found an association between approach motivation and relative left frontal activity (Carver & Harmon-Jones, 2009; van Honk & Shutter, 2006). Thus, the supine posture required by most current fMRI scanners may reduce, but not necessarily eliminate, neural activity associated with approach motivation.

This chapter reviewed evidence suggesting that body postures and movements influence approach motivational responses. These studies serve as a reminder that cognition and emotion are for action, lending support to the idea that the cognitions and responses experienced by humans relate to the action-readiness of the body in that moment. Specifically, assuming a forward-leaning posture potentiates approach responses whereas assuming a reclining posture reduces approach. We should consider the conceptual consequences of this research as we develop more embodied motivational theories.

References

Adelmann, P. K., Zajonc, R. B. (1989). Facial efference and the experience of emotion. *Annual Review of Psychology, 40,* 249-80.

Amodio, D. M., & Harmon-Jones, E. (2011). Trait emotions and affective modulation of the startle eyeblink: On the unique relationship of trait anger. *Emotion*, *11*, 47-51.

Bastian, B., Loughnan, S., Haslam, N., & Radke, H. R. (2012). Don't mind meat? The denial of mind to animals used for human consumption. *Personality and Social Psychology Bulletin*, *38*(2), 247-256.

Berkman, E.T., & Lieberman, M.D. (2010). Approaching the good and avoiding the bad: Separating action and valence using dorsolateral prefrontal cortical asymmetry. *Journal of Cognitive Neuroscience, 22*, 1970-1979.

Blumenthal, T. D., Cuthbert, B. N., Filion, D. L., Hackley, S., Lipp, O. V., & van Boxtel, A. (2005). Committee report: Guidelines for human startle eyeblink electromyographic studies. *Psychophysiology*, *42*, 1-15.

Briggs, K. B. & Martin, F. H. (2009). Affective picture processing and motivational relevance: arousal and valence effects on ERPs in an oddball task. *International journal of Psychophysiology, 72,* 299-306.

Cacioppo, J. T., Priester, J. R., & Berntson, G. G. (1993). Rudimentary determinants of attitudes: II. Arm flexion and extension have differential effects on attitudes. *Journal of Personality & Social Psychology, 65*, 5-17.

Carver, C. S., & Harmon-Jones, E. (2009). Anger is an approach-related affect: Evidence and implications. *Psychological Bulletin*, *135*, 183-204.

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS Scales. *Journal of Personality & Social Psychology, 67*, 319-333.

Centerbar, D. B., & Clore, G. L. (2006). Do approach-avoidance actions create attitudes? *Psychological Science*, *17*, 22-29.

Coan, J. A., Allen, J. J. B. & Harmon-Jones, E. (2001). Voluntary facial expression and hemispheric asymmetry over the frontal cortex. *Psychophysiology, 38,* 912-925.

Darwin, C. (1872). *The expression of the emotions in man and animals*. London: Murray.

Davidson, R. J., & Fox, N. (1982). Asymmetric brain activity discriminates between positive and negative affective stimuli in 10 month old infants. *Science, 218*, 1235-1237.

Davis, M. (2006) Neural systems involved in fear and anxiety measured with fear-potentiated startle. *American Psychologist, 61*, 741-756.

Eder, A.B., & Rothermund, K. (2008). When do motor behaviors (mis)match affective stimuli? An evaluative coding view of approach and avoidance reactions. *Journal of Experimental Psychology: General*, *137*, 262-281.

Ekman, P., & Davidson, R. J. (1993). Voluntary smiling changes regional brain activity. *Psychological Science*, *4*, 342-345.

Ekman, P., Levenson, R. W., & Friesen. W. V, (1983).Autonomic nervous system activity distinguishes among emotions. *Science, 221,* 1208-1210.

Gable, P. A., & Harmon-Jones, E. (2008). Relative left frontal activation to appetitive stimuli: Considering the role of individual differences. *Psychophysiology, 45,* 275-278.

Hajcak, G., Weinberg, A., MacNamara, A., & Foti, D. (2011). ERPs and the study of emotion. In S. J. Luck, & E. S. Kappenman (Eds.), *Handbook of event-related potential components.* New York: Oxford University Press.

Harmon-Jones, E. (2003). Clarifying the emotive functions of asymmetrical frontal cortical activity. *Psychophysiology, 40,* 838-848.

Harmon-Jones, E. (2004). On the relationship of anterior brain activity and anger: Examining the role of attitude toward anger. *Cognition and Emotion, 18*, 337-361.

Harmon-Jones, E. (2006). Unilateral right-hand contractions cause contralateral alpha power suppression and approach motivational affective experience. *Psychophysiology, 43,* 598-603.

Harmon-Jones, E., & Allen, J. J. B. (1998). Anger and frontal brain activity: EEG asymmetry consistent with approach motivation despite negative affective valence. *Journal of Personality and Social Psychology, 74,* 1310-1316.

Harmon-Jones, E., Gable, P. A., & Peterson, C. K. (2010). The role of asymmetric frontal cortical activity in emotion-related phenomena: A review and update. *Biological Psychology, 84,* 451-462.

Harmon-Jones, E., Gable, P. A., & Price, T. F. (2011a). Leaning embodies desire: Evidence that leaning forward increases relative left frontal cortical activation to appetitive stimuli. *Biological Psychology, 87,* 311-313.

Harmon-Jones, E., Gable, P. A., & Price, T. F. (2011b). Toward an understanding of the influence of affective states on attentional tuning: Comment on Friedman and Forster (2010). *Psychological Bulletin, 137,* 508-512.

Harmon-Jones, E., Gerdjikov. T., & Harmon-Jones, C. (2008).The effect of induced compliance on relative left frontal cortical activity: A test of the action-based model of dissonance. *European Journal of Social Psychology, 38,* 35-45.

Harmon-Jones, E., Harmon-Jones, C., Fearn, M., Sigelman, J. D., & Johnson, P. (2008). Action orientation, relative left frontal cortical activation, and spreading of alternatives: A test of the action-based model of dissonance. *Journal of Personality and Social Psychology, 94,* 1-15.

Harmon-Jones, E., Harmon-Jones, C., Serra, R., & Gable, P. A. (2011). The effect of commitment on relative left frontal cortical activity: Tests of the action-based model of dissonance. *Personality and Social Psychology Bulletin, 37,* 395-408.

Harmon-Jones, E., & Peterson, C. K. (2009). Supine body position reduces neural response to anger evocation. *Psychological Science, 20,* 1209-1210.

Harmon-Jones, E., & Sigelman, J. (2001). State anger and prefrontal brain activity: Evidence that insult-related relative left-prefrontal activation is associated with experienced anger and aggression. *Journal of Personality and Social Psychology, 80,* 797-803.

Harmon-Jones, E., Sigelman, J. D., Bohlig, A. & Harmon-Jones, C. (2003). Anger, coping, and frontal cortical activity: The effect of coping potential on anger-induced left frontal activity. *Cognition & Emotion, 17,* 1-24.

Harmon-Jones, E., Vaughn-Scott, K., Mohr, S., Sigelman, J., & Harmon-Jones, C. (2004). The effect of manipulated sympathy and anger on left and right frontal cortical activity. *Emotion, 4,* 95-101.

Havas, D. A., Glenberg, A. M., Gutowski, K. A., Lucarelli, M. J., & Davidson, R. J. (2010). Cosmetic use of botulinum toxin-a affects processing of emotional language. *Psychological Science, 21*, 895-900.

Hawk, L. W., & Kowmas, A. D. 2003. Affective modulation and prepulse inhibition of startle among undergraduates high and low in behavioural inhibition and approach. *Psychophysiology, 40*, 131-138.

Hennenlotter, A., Dresel, C., Castrop, F., Baumann, A. O. C., Wohlschlager, A. M., & Haslinger, B. (2009). The link between facial feedback and neural activity within central circuitries of emotion-New insights from botulinum toxin-induced denervation of frown muscles. *Cerebral Cortex*, *19*, 537-542.

James, W. (1890). *The principles of psychology*.

Keil, A., Bradley, M. M., Hauk, O., Rockstroh, B., Elbert, T., & Lang P. J. (2002). Large scale neural correlates of affective picture processing. *Psychophysiology, 39*, 641-649.

Laird, J. D. (1974). Self-attribution of emotion: The effects of expressive behavior on the quality of emotional experience. *Journal of Personality and Social Psychology, 29,* 475-486.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1990). Emotion, attention, and the startle reflex. *Psychological Review, 97*, 377-398.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999). International affective picture system (IAPS): Instruction manual and affective ratings. *The Center for Research in Psychophysiology*, *University of Florida*.

Levenson, R. W. (1992). Autonomic nervous system differences among emotions. *Psychological Science, 3*, 23-27.

Levenson, R. W., Ekman, P. & Friesen, W. V. (1990). Voluntary facial action generates emotion-specific autonomic nervous system activity. *Psychophysiology, 27*, 363-384.

Peterson, C. K., Gable, P., & Harmon-Jones, E. (2008). Asymmetrical frontal ERPs, emotion, and behavioral approach/inhibition sensitivity. *Social Neuroscience, 3*, 113-124.

Peterson, C. K., Shackman, A. J., & Harmon-Jones, E. (2008). The role of asymmetrical frontal cortical activity in aggression. *Psychophysiology*, *45*, 86-92.

Price, T. F., & Harmon-Jones, E. (2010). Approach motivational body postures lean towards left frontal brain activity. *Psychophysiology*, *48,* 718-722.

Price, T. F., Dieckman, L., & Harmon-Jones, E. (2012). Embodying approach motivation: Body posture influences startle eyeblink and event-related potential responses to appetitive stimuli. *Biological Psychology, 90,* 211-217.

Rinn, W. E. (1984). The neuropsychology of facial expression: A review of the neurological and psychological mechanisms for producing facial expression. *Psychological Bulletin, 95*, 52-77.

Riskind, J. H., & Gotay, C. C. (1982). Physical posture: Could it have regulatory or feedback effects on motivation and emotion? *Motivation & Emotion, 6*, 273-298.

Robinson, R.G., Boston, J.D., Starkstein, S.E., & Price, T. R. (1988). Comparison of mania and depression after brain injury: causal factors. *America Journal of Psychiatry, 145,* 172-178.

Sabatinelli, D., Lang, P. J., Keil, A., & Bradley, M.. M. (2007). Emotional perception: Correlation of functional MRI and event-related potentials. *Cerebral Cortex*, *17*, 1085-1091.

Schiff, B. B., & Lamon, M. (1989). Inducing emotion by unilateral contraction of facial muscles: A new look at hemispheric specialization and the experience of emotion. *Neuropsychologia*, *27*, 923-935.

Schiff, B. B., & Lamon, M. (1994). Inducing emotion by unilateral contraction of hand muscles. *Cortex*, *30*, 247-254.

Schupp, H., Cuthbert, B., Bradley, M., Hillman, C., Hamm, A., & Lang, P. (2004). Brain processes in emotional perception: Motivated attention. *Cognition & Emotion, 18*, 593-611.

Starkstein, S. E., Boston, J. D., & Robinson, R. G. (1988). Mechanisms of mania after brain injury. *Journal of Nervous and Mental Disease*, *176*, 87-99.

Strack, F., Martin, L. L. & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: A nonobtrusive test of the facial feedback hypothesis. *Journal of Personality & Social Psychology, 54*, 768-776.

Taylor, S. P. (1966). Aggressive behavior and physiological arousal as a function of provocation and the tendency to inhibit aggression. *Journal of Personality, 35*, 397-310.

Tom, G., Pettersen, P., Lay, T., Burton, T., & Cook, J. (1991). The role of overt head movement in the formation of affect. *Basic and Applied Social Psychology, 12*, 281-289.

Tomarken, A. J., & Zald, D. H. (2009). Conceptual, methodological, and empirical ambiguities in the linkage between anger and approach: Comment on Carver and Harmon-Jones, *Psychological Bulletin, 135*, 209-214.

van Honk, J., & Schutter, D. J. (2006). From affective valence to motivational direction: The frontal asymmetry of emotion revised. *Psychological Science, 17*, 963-965.

Verona, E., Sadeh, N., & Curtin, J. J. (2009). Stress-induced asymmetric frontal brain activity and aggression risk. *Journal of Abnormal Psychology, 118*, 131-145.

Vrana, S. R., Spence, E. L., & Lang, P. J. (1988). The startle probe response: A new measure of emotion? *Journal of Abnormal Psychology, 97*, 487-491.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063-1070.

Zajonc, R. B., Murphy, S. T., & Inglehart, M. (1989). Feeling and facial efference: Implication of the vascular theory of emotion. *Psychological Review*, *96*, 395-416.